S/C Bus Fabrication, Assembly, Integration & Test

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Top Level Requirements (1 of 2)

- **Define and Implement a System Test Program That Qualifies FAME Flight Hardware For All Handling, Transportation, Launch, and Mission Environments**
  - **Environmental Tests and Levels Defined in NCST-TP-FM001, *FAME Integration & Test Plan***
- **All Flight Hardware Activities Comply With SSD-D-FM005, FAME Product Assurance Plan**
  - **Includes Traceability Requirements**
  - **Includes Control of Non-conforming Materials**
  - **Includes Failure Reporting and Corrective Action System**

Top Level Requirements (2 of 2)

- **All Flight Hardware Activities Comply With SSD-D-FM006, *FAME Safety, Reliability & Quality Assurance Plan***

- **Maintain FAME Flight Hardware Cleanliness Levels As Specified in NCST-D-FM007, *FAME Contamination Control Plan*, Through All Phases of Assembly, Integration, Test, Transportation, and Field Operations**

- **Configuration Control Shall Be in Accordance With NCST-D-FM008, *FAME Configuration Management Plan***

- **FAME Flight Hardware Shall Be Protected During Ground Handling and Transportation So That the Environmental Conditions to Not Exceed Flight or Orbital Conditions**

Manufacturing Controls

- **Production Control**
  - **Build and Inspect Flight Hardware Only to Released and Configuration Controlled Assembly Drawings (And Any Associated Procedures & Process Specifications)**
- **Quality Assurance**
  - **Quality Assurance Personnel Monitor Assembly Activities and Perform Formal Inspections of Completed Subassemblies and Assemblies**
- **Identification & Marking**
  - **Interchangeable Subassemblies Identified With Nameplates**
  - **Where Practical, Components Will Be Marked With Part Number & Serial Number**
  - **Test Articles Permanently Marked “Not For Flight Use”**

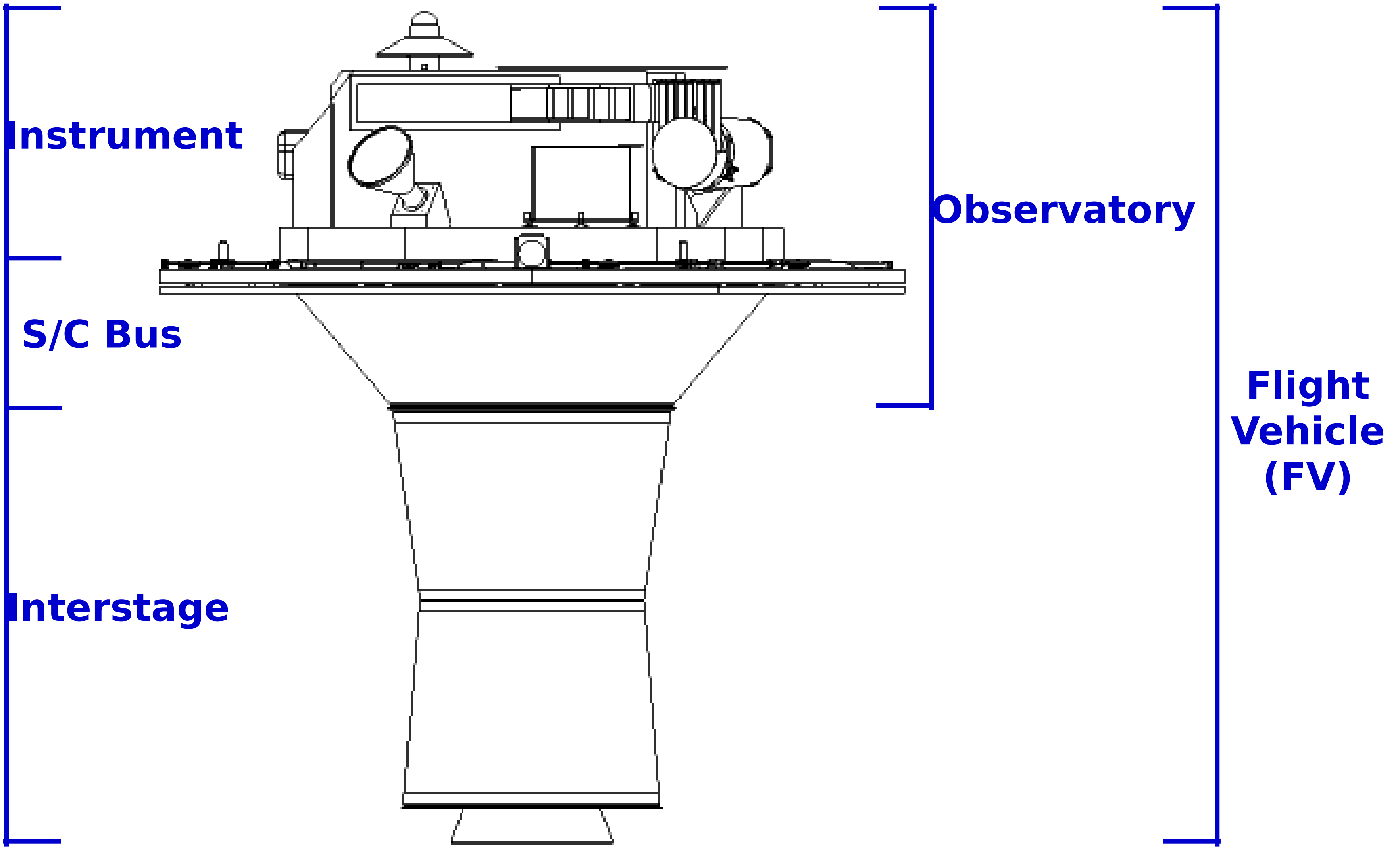
Configuration Management

- Configuration Control Per FAME Configuration Management Plan, NCST-D-FM008
  - Formal System For Identification, Change Control, and Accounting of All Hardware and Software Defined As a Configuration Item
  - Configuration Change Notices (CCN's)
    - Primary Vehicle for Initiating Changes to Configuration Items
    - Submitted to the Configuration Control Board for Review
- As Built Configuration Lists (ABCL)
  - Generated by Quality Assurance to Document Precise Configurations at Discrete Points in the I&T Flow
    - For Each Component Build
    - To Document Component or Assembly Configuration for Each Environmental Test

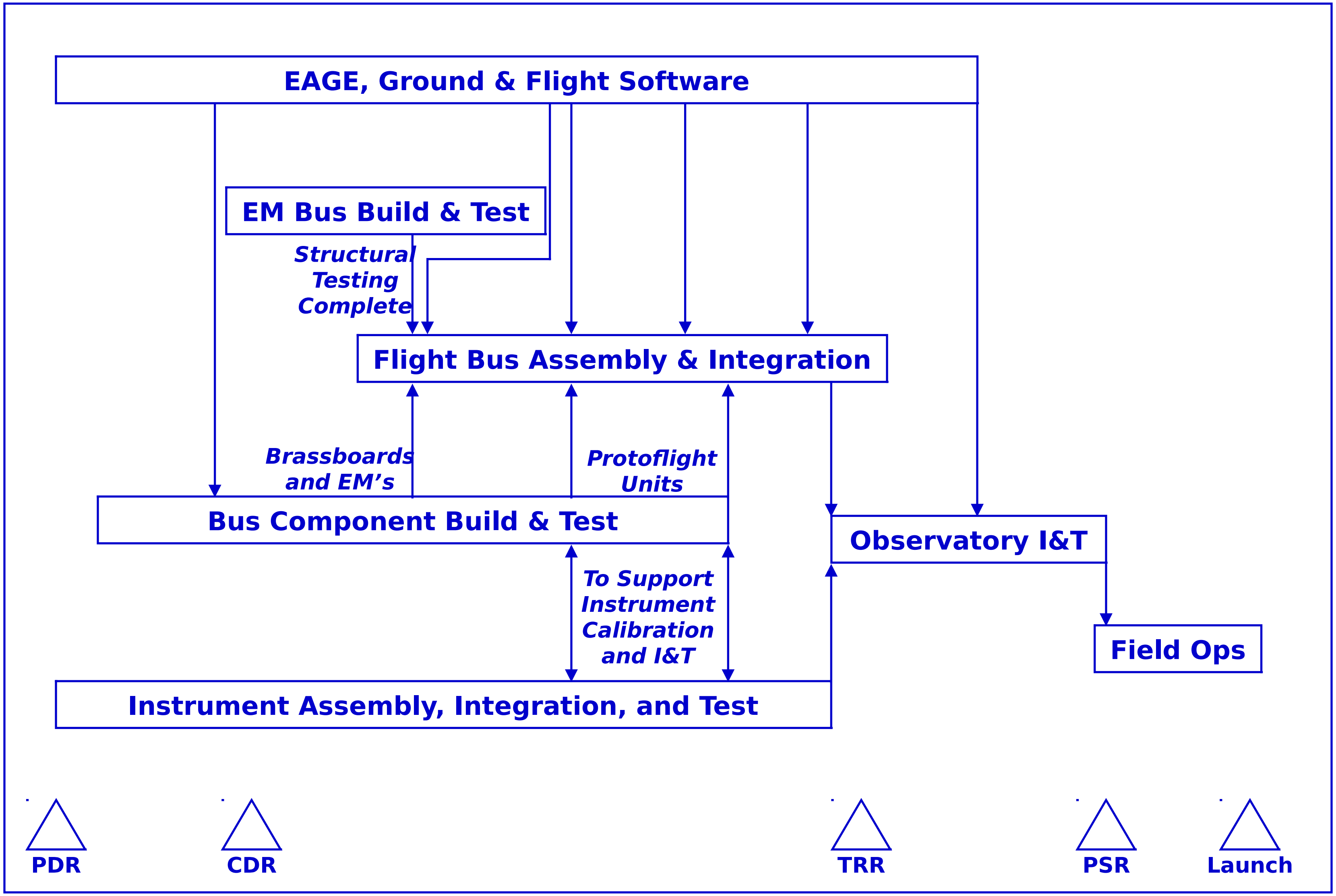
Build Documentation

- Travelers (Fabrication Control Sheets) Are the Key Method for Flight Hardware Build Documentation
  - Uniquely Numbered Traveler Created For Each Manufactured Item and Assembly
    - Used to Document All Activities and Tests Performed on a Configuration Item
    - Travels With Hardware As It Passes Through All Phases of Fabrication, Assembly, Integration, and Test
    - Travelers Are the Primary Vehicle for Maintaining Flight Hardware Traceability
    - Retained As Part of Permanent Build File
  - Three Ring Binder "Logbooks" Are Often Created to Hold Travelers and All of the Supporting Documentation (Certifications, Procedures, Test Printouts and Reports, ABCL's)
- Daily Logs of Activities Are Maintained By FAME Integration Team

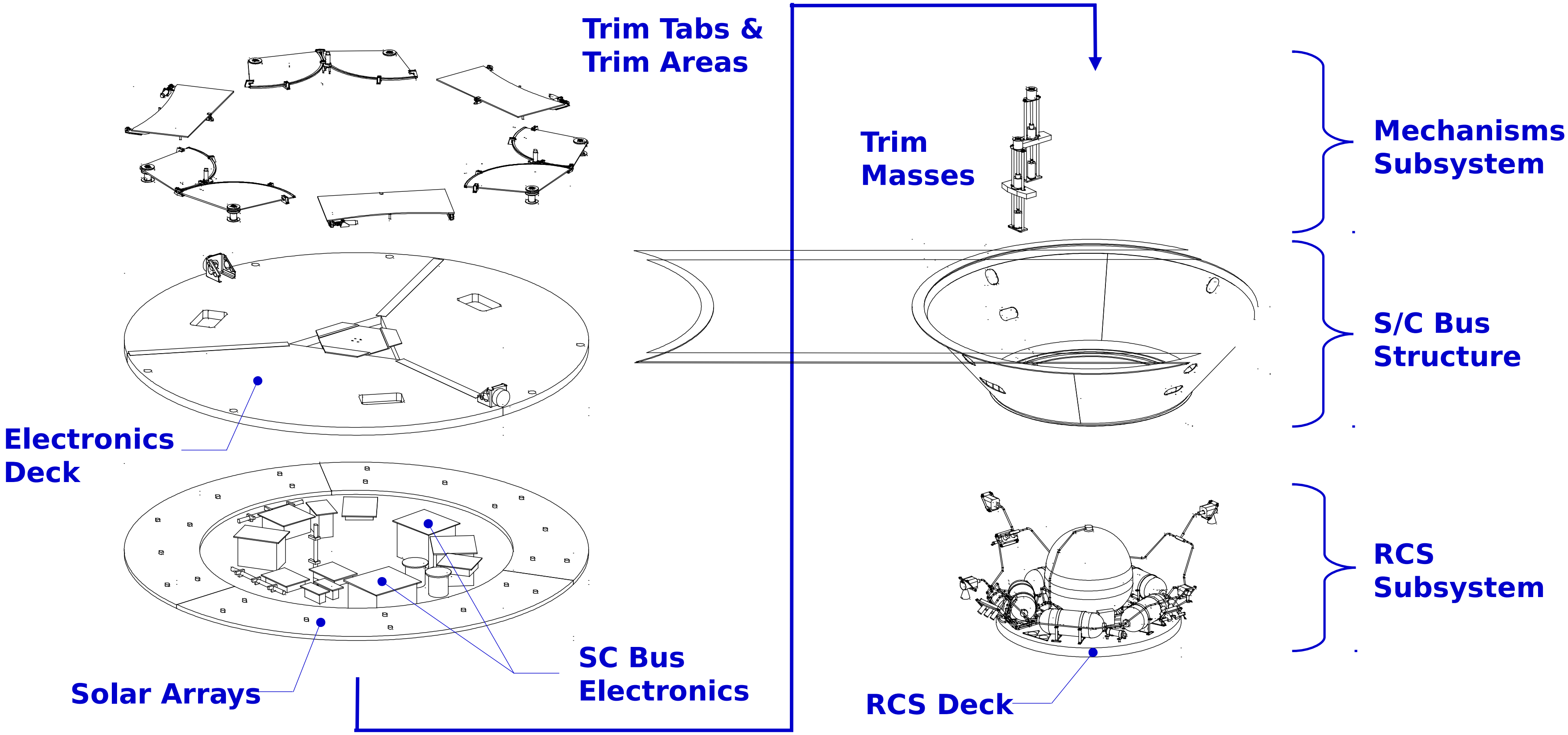
Assembly Nomenclature



Observatory Development Flow



Bus Assembly Overview



- The FAME Bus is Designed for Modular Assembly & Integration
  - Ground Support Equipment (MAGE & EAGE), the Schedule, and Resource Allocation Support Parallel Build & Integration Efforts

Test Philosophy (1 of 2)

- Overall Philosophy for Test Program Is Based Upon the Protoflight Approach
  - Single Protoflight Spacecraft (& Components) Are Used for Design Qualification and for Flight
    - With Bus Structural Test Article (Engineering Model) to Reduce Risk & Free Up Flight Vehicle for Integration
  - Protoflight Spacecraft & Components Are Subjected to Environments More Severe Than Those Expected During the Mission
- Integration & Test Plan, NCST-TP-FM001, Defines a Comprehensive Test Program at the Component and the System Levels of Assembly
  - Specifies Tests to Be Performed
  - Specifies Prescribed Levels for Each Test
  - Contains Overall Program Environmental Test Matrix
  - Contains Test Verification Report Format
- Design, Loads, and Analysis Plan, NSCT-D-FM017
  - Defines Environments

Test Philosophy (2 of 2)

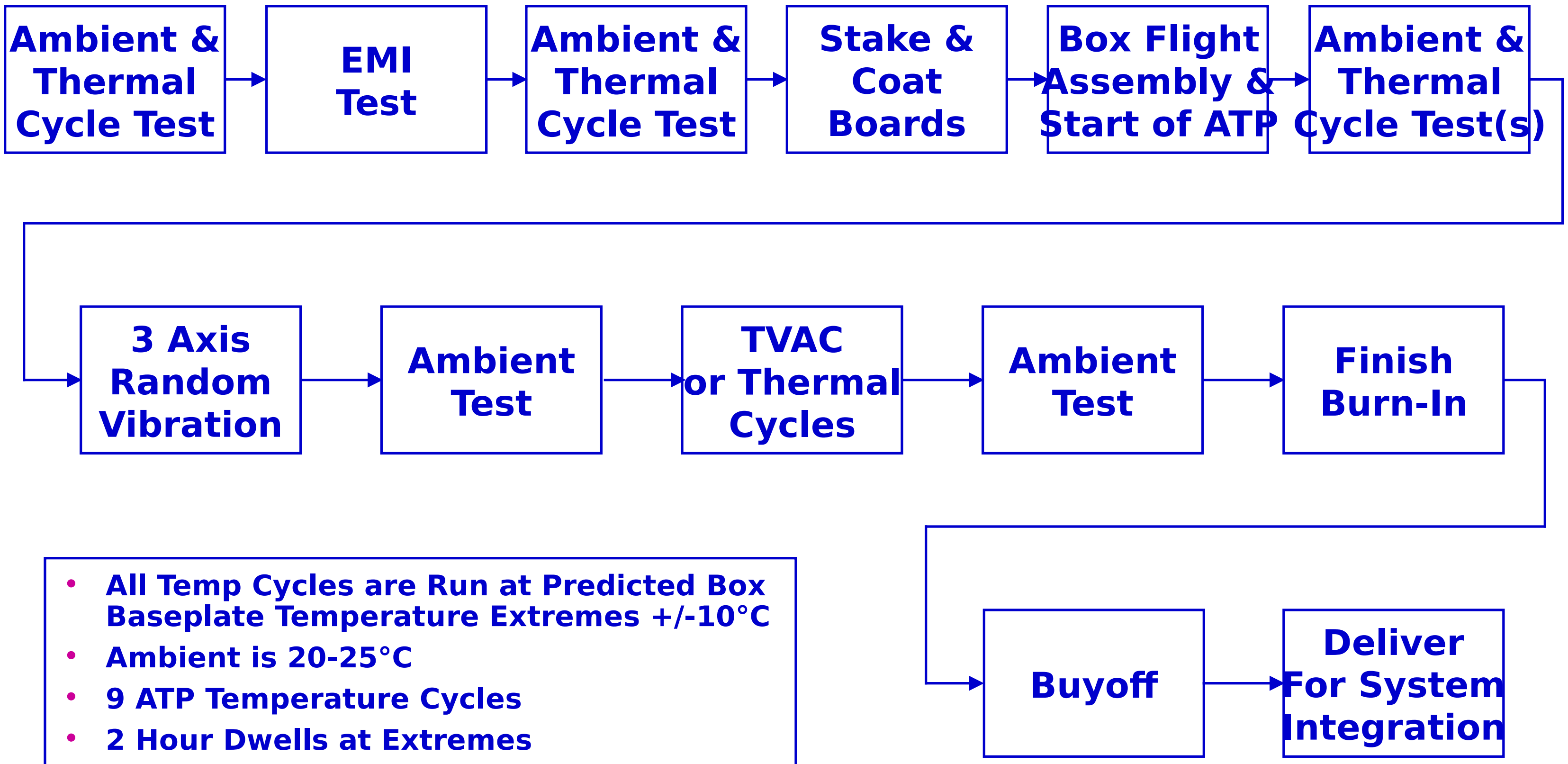
- **Two Main Categories of Tests:**
  - **Functional and Performance Tests**
    - **Verify Electrical Systems/Software Operation**
    - **Verify Instrument Operation**
    - **Verify Mechanism Operation**
    - **Verify Propulsion System Function**
    - **Verify Thermal Design**
  - **Environmental Tests**
    - **Verify Ability to Survive Launch and On-Orbit Conditions**
      - **Vibration, Acoustic**
      - **Static Loads**
      - **Pyrotechnic Shock**
      - **Thermal Vacuum**
      - **EMI/EMC**

Performance Test: Exercises All Parts of Hardware and Software, Verifies Every Function & Mode Possible. Performed at Low, Nominal & High Bus Voltages
Functional Test: Verifies All Hardware Connections & Basic Functionality. Typically Created by Removing Parts of Performance Test to Reduce Duration & Complexity

Component Testing Approach

- **Functional and Performance Testing**
  - **Acceptance Test Programs (or Component Specifications for Purchased Items) Are Developed for Each Component**
    - **Incorporates Unique Functional & Performance Testing Requirements for Each Component**
    - **After the Successful Conclusion of Each Component ATP, a Buyoff Is Held Prior to Delivery of Unit for System Integration**
- **Environmental Testing**
  - **Minimum Test Requirements Defined in NCST-TP-FM001**
    - **Any Additional Testing Requirements Are Captured in the Component Acceptance Test Plan**

Generic Component Testing Flow



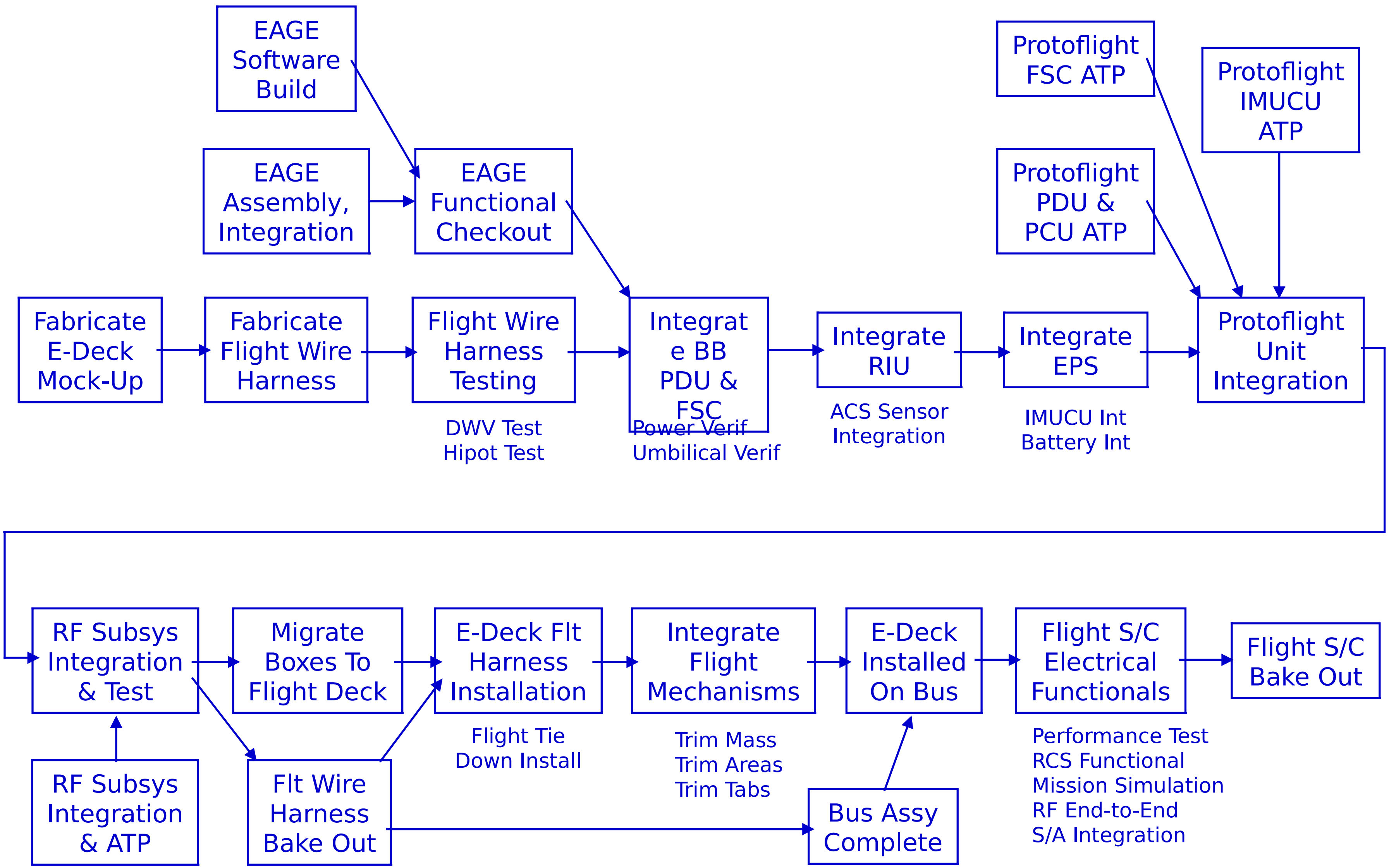
- All Temp Cycles are Run at Predicted Box Baseplate Temperature Extremes +/-10°C
- Ambient is 20-25°C
- 9 ATP Temperature Cycles
- 2 Hour Dwells at Extremes
- Minimum of 200 Hours ATP Test Time
- Final 50 Hours Failure Free
- Static Loads Qualification by Analysis or by Sine Burst Testing

Example Above is for Protoflight Electronics Box

System Testing Approach

- Electrical Functional and Performance Testing
  - An Electronics Deck Mechanical Mock-up Is Produced to Support Electrical I&T Activities
    - Initially, the Deck (Aluminum Honeycomb) Is Outfitted With Box Simulators and Used As Fixture for Wire Harness Fabrication
    - Box Simulators Are Replaced With Brassboard and Engineering Model Units As They Become Available. EAGE Is Connected Up and Ground Software Scripts Are Developed to Exercise Functions and Measure Performance
    - As Integration Progresses, Protoflight Units Replace Non-flight Units on the Mock-up Deck
    - The Flight Electronics and Harness Are Migrated to the Flight Electronics Deck When It Becomes Available
  - The Test Cases and Perform Files That Are Developed During the Electrical Integration and Test Activities Above Are Used to Develop the Functional & Performance Test Description Document

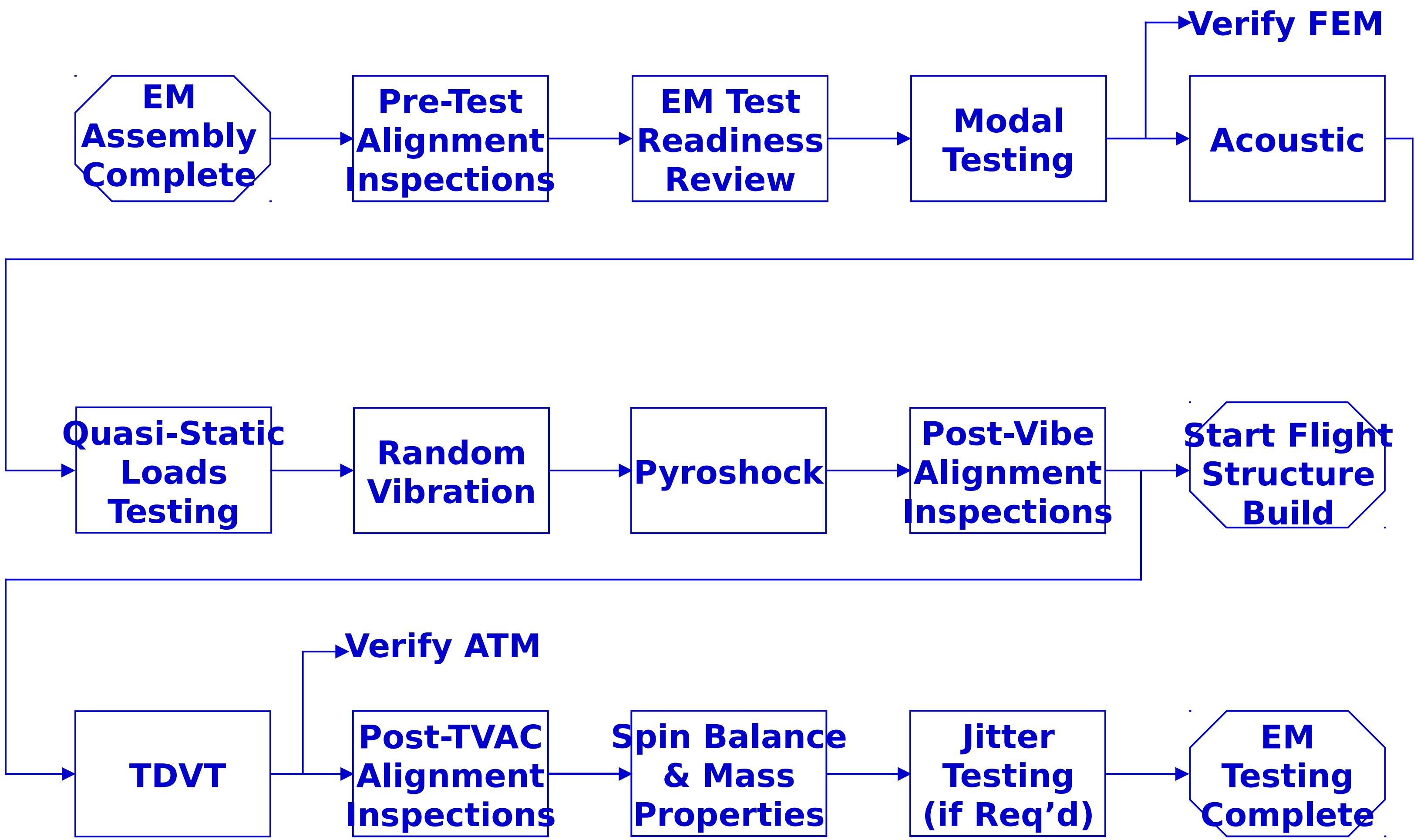
Electrical/Software I&T Flow



System Testing Approach

- **Environmental Testing**
  - **An Engineering Model (EM) Structure Will Be Built and Populated With Mass Simulators for the Instrument, The AKM, and All Components**
    - **The EM Will Be Used For Modal Testing and For Structural Loads Qualification of the FAME Design**
    - **The EM Will Undergo Vibro-Acoustic Testing at the Qualification Level (Flight +6db for 2 Minutes/axis)**
    - **The EM Will Also Be Used For Pyroshock, TDVT, and As a Pathfinder For Alignments and Spin Balance**
    - **The EM Also Serves As a Pathfinder for Manufacturing, Handling, Test Procedures, and Fit Checks**
    - **Data From EM Testing Will Be Used to Verify FEM, Verify ATM, & Revise Component and Instrument Random Vibe and Shock Spectra**
  - **Flight Observatory Environmental Testing Is Covered in Following Section**

EM Test Flow

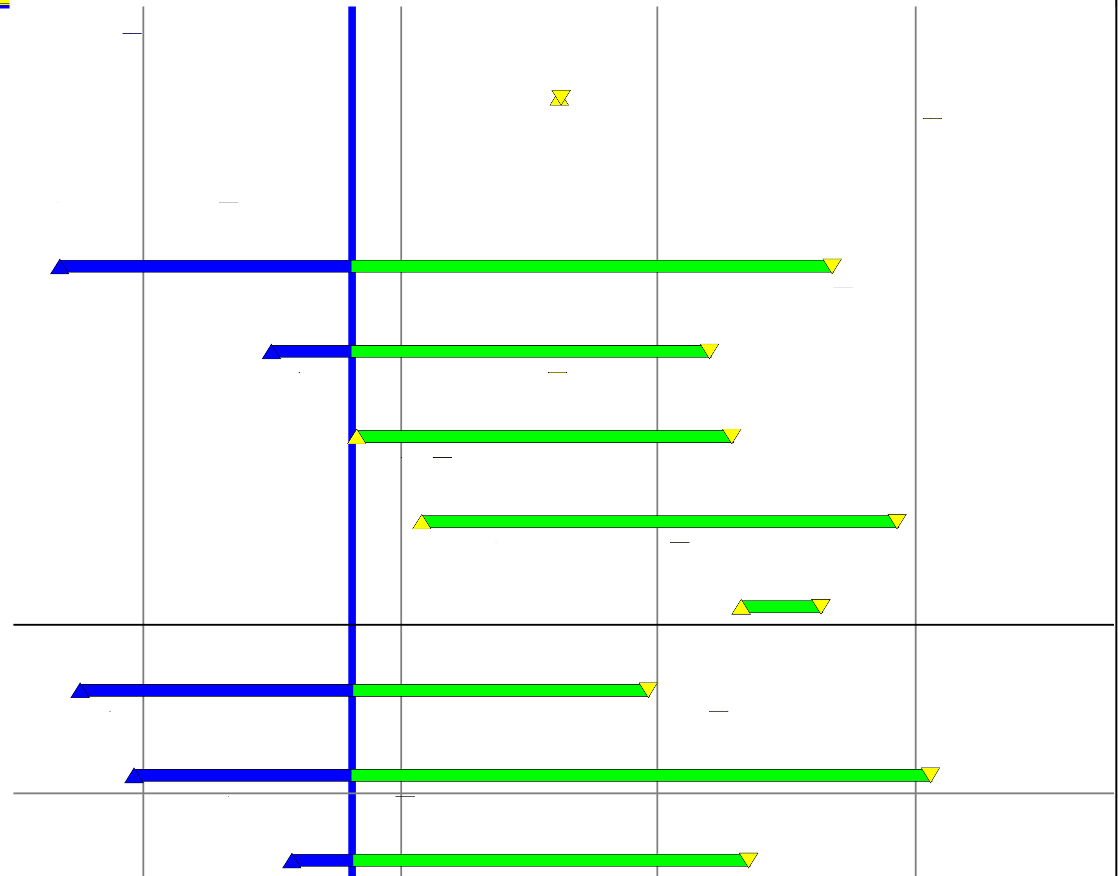

EM Assembly Complete
Pre-Test Alignment Inspections
EM Test Readiness Review
Modal Testing
Verify FEM
Acoustic
Quasi-Static Loads Testing
Random Vibration
Pyroshock
Post-Vibe Alignment Inspections
Start Flight Structure Build
TDVT
Verify ATM
Post-TVAC Alignment Inspections
Spin Balance & Mass Properties
Jitter Testing (if Req'd)
EM Testing Complete

Environmental Test Matrix

Hardware Description						Structural & Mechanical Testing												EMI/EMC																Thermal					
Level of Assembly	Item	Unit Type	Modal Survey	Loads (Static or Quasi-Static)	Random Vibration	Acoustic	Pyroshock	Proof Pressure	Leak	Mechanism Functional	Torque Ratio	Life Testing	Spin Balance	Magnetic Balance	Conducted Emissions (CE01)	Conducted Emissions (CE03)	Conducted Emissions (CE06)	Conducted Susceptibility (CS01)	Conducted Susceptibility (CS02)	Conducted Susceptibility (CS03)	Conducted Susceptibility (CS04)	Conducted Susceptibility (CS05)	Conducted Susceptibility (CS06)	Electrical Power Surge	Signal/Control Circuits	Radiated Emissions (RE02)	Radiated Susceptibility (RS03)	Electrostatic Discharge	DC Power Quality	Number of Thermal Cycles	Number of TVAC Cycles	Thermal Design Verification	Bakeout	Temperature Design Limits	Protoflight Test Temperature Limits	Comments
P/L	Observatory/Flight Vehicle	PF	–	–	X	X	X	–	–	X	–	–	X	–	–	–	–	–	–	–	–	–	–	–	–	X	X	X	X	–	4	–	–	0 / +40	-10 / +50	
I	Instrument	PF	X	–	X	–	–	–	–	X	–	–	–	–	X	X	–	X	X	–	–	–	X	X	X	X	X	X	–	–	4	X	X	-30 / +25	-40 / +35	Optics Temp Limit
S/C	Flight Spacecraft Bus	PF	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	X	0 / +40	-10 / +50	
S	Bus & Interstage Structure	EM	X	X	X	X	X	–	–	X	–	–	X	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	X	–	0 / +40	-10 / +50	
	RCS Subsystem																																			
C	AKM	F	–	A/T	X	–	–	X	X	–	–	–	X	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+4 / +32	-6 / +42	
C	Propellant Tank	F	–	A/T	X	–	–	X	X	–	–	Q	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+7 / +30	-3 / +40	Dry Test Temp Limits
C	Pressurant Tank	F	–	A/T	X	–	–	X	X	–	–	Q	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+7 / +40	-3 / +50	Dry Test Temp Limits
C	Thruster 5.0 Lb	F	–	A/T	X	–	–	X	X	X	–	Q	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+7 / +40	-3 / +50	Dry Test Temp Limits
C	Thruster 0.2 Lb	F	–	A/T	X	–	–	X	X	X	–	Q	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+7 / +40	-3 / +50	Dry Test Temp Limits
C	Propellant Lines	PF	–	A/T	–	–	–	X	X	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+7 / +40	-3 / +50	Dry Test Temp Limits
C	Fill Valves	F	–	A/T	X	–	–	X	X	X	–	Q	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+7 / +40	-3 / +50	Dry Test Temp Limits
C	Pressure Transducer	F	–	A/T	X	–	–	X	X	X	–	Q	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+7 / +40	-3 / +50	Dry Test Temp Limits
C	Propellant Filter	F	–	A/T	X	–	–	X	X	X	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+7 / +40	-3 / +50	Dry Test Temp Limits
C	Propellant Latch Valve	F	–	A/T	X	–	–	X	X	X	–	Q	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+7 / +40	-3 / +50	Dry Test Temp Limits
C	Pyro Isolation Valve	F	–	A/T	X	–	–	X	X	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+7 / +40	-3 / +50	Dry Test Temp Limits
	ADCS Subsystem																																			
C	IMU	F	–	A/T	X	–	–	–	–	–	–	–	–	–	X	X	–	X	X	–	–	–	X	X	X	X	X	X	–	9	–	–	–	-54 / +71	-64 / +81	
C	Spinning Sun Sensors	F	–	A/T	X	–	–	–	–	–	–	–	–	–	X	X	–	X	X	–	–	–	X	X	X	X	X	X	–	9	–	–	–	-10 / +60	-20 / +70	
C	Sun Sensor Electronics	F	–	A/T	X	–	–	–	–	–	–	–	–	–	X	X	–	X	X	–	–	–	X	X	X	X	X	X	–	9	–	–	–	-10 / +60	-20 / +70	
C	Coarse Sun Sensor	F	–	A/T	X	–	–	–	–	–	–	–	–	–	X	X	–	X	X	–	–	–	X	X	X	X	X	X	–	9	–	–	–	-125 / +80	-135 / +90	
C	Torque Rods	F	–	A/T	X	–	–	–	–	–	–	–	–	–	X	X	–	X	X	–	–	–	X	X	X	X	X	X	–	9	–	–	–	0 / +40	-10 / +50	
C	Magnetometers	F	–	A/T	X	–	–	–	–	–	–	–	–	–	X	X	–	X	X	–	–	–	X	X	X	X	X	X	–	9	–	–	–	-30 / +50	-40 / +60	
C	Star Trackers	F	–	A/T	X	–	–	–	–	–	–	–	–	–	X	X	–	X	X	–	–	–	X	X	X	X	X	X	–	9	–	–	–	-15 / +40	-25 / +50	-15 / 0 On-Orbit Limit
C	Star Tracker DPU	F	–	A/T	X	–	–	–	–	–	–	–	–	–	X	X	–	X	X	–	–	–	X	X	X	X	X	X	–	9	–	–	–	0 / +40	-10 / +50	
	Mechanism Subsystem																																			
C	Trim Tabs	Q,F	–	A/T	X	–	–	–	–	X	X	Q	–	–	X	X	–	X	X	–	–	–	X	X	X	X	X	X	–	–	9	–	–	-80 / +40	-90 / +50	-40 / 80 Motor Limit
C	Trim Areas	Q,F	–	A/T	X	–	–	–	–	X	X	Q	–	–	X	X	–	X	X	–	–	–	X	X	X	X	X	X	–	–	9	–	–	-80 / +40	-90 / +50	-40 / 80 Motor Limit
C	Trim Masses	Q,F	–	A/T	X	–	–	–	–	X	X	Q	–	–	X	X	–	X	X	–	–	–	X	X	X	X	X	X	–	–	9	–	–	0 / +40	-10 / +50	
C	Kickoff Canisters	Q,F	–	A/T	X	–	–	–	–	X	X	Q	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	9	–	–	-20 / +50	-30 / +60	
C	Marmon Clamp	Q,F	–	A/T	X	–	–	–	–	X	X	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	9	–	–	-20 / +60	-30 / +70	
	EPS Subsystem																																			
C	Solar Arrays	Q,F	–	X	–	X	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4	–	–	-80 / +100	-90 / +110	
C	Battery	Q,F	–	A/T	X	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4	–	–	0 / +30	-10 / +40	
C	PDU	PF	–	A/T	X	–	–	–	–	–	–	–	–	–	X	X	–	X	X	–	–	–	X	X	X	X	X	X	X	9	–	–	–	0 / +40	-10 / +50	
C	PCU	PF	–	A/T	X	–	–	–	–	–	–	–	–	–	X	X	–	X	X	–	–	–	X	X	X	X	X	X	X	9	–	–	–	0 / +40	-10 / +50	
C	SAJB	PF	–	A/T	X	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	9	–	–	–	0 / +40	-10 / +50	
C	BCB	PF	–	A/T	X	–	–	–	–	–	–	–	–	–	X	X	–	X	X	–	–	–	X	X	X	X	X	X	–	9	–	–	–	0 / +40	-10 / +50	
C	Safe/Arm Box	PF	–	A/T	X	–	–	–	–	–	–	–	–	–	X	X	–	X	X	–	–	–	X	X	X	X	X	X	–	9	–	–	–	0 / +40	-10 / +50	
S	Harness	PF	–	A/T	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	X	-20 / +60	-30 / +70	
	RF Sybsystem																																			
C	Transponder	PF	–	A/T	X	–	–	–	–	–	–	–	–	–	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	–	9	–	–	0 / +40	-10 / +50	
C	Diplexer	F	–	A/T	X	–	–	–	–	–	–	–	–	–	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	–	9	–	–	0 / +40	-10 / +50	
C	Hybrid/Coupler	F	–	A/T	X	–	–	–	–	–	–	–	–	–	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	–	9	–	–	0 / +40	-10 / +50	
C	Antennas	Q,F	–	A/T	X	–	–	–	–	–	–	–	–	–	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	–	9	–	–	-30 / +70	-40 / +80	
C	Transfer Switches	F	–	A/T	X	–	–	–	–	–	–	–	–	–	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	–	9	–	–	0 / +40	-10 / +50	
C	SPDT Switches	F	–	A/T	X	–	–	–	–	–	–	–	–	–	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	–	9	–	–	0 / +40	-10 / +50	
C	Gore Cables	PF	–	A/T	–	–	–	–	–	–	–	–	–	–	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	–	–	–	–	-20 / +60	-30 / +70	
	CT&DH Subsystem																																			
C	FSC	PF	–	A/T	X	–	–	–	–	–	–	–	–	–	X	X	–	X	X	–	–	–	X	X	X	X	X	X	–	9	–	–	–	0 / +40	-10 / +50	
C	RIU	F	–	A/T	X	–	–	–	–	–	–	–	–	–	X	X	–	X	X	–	–	–	X	X	X	X	X	X	–	9	–	–	–	0 / +40	-10 / +50	
	TCS Subsystem																																			
C	MLI Blankets	PF	–	A/T	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	X	-125/+125	-135/+135	

Bus Schedule (1 of 2)

tivity ID	Activity Description	Start Type	Finish



Start Date	01JAN00
Finish Date	28JAN05
Data Date	24OCT01
Run Date	24OCT02 09:33

Early Bar
Progress Bar
Critical Activity

FAME

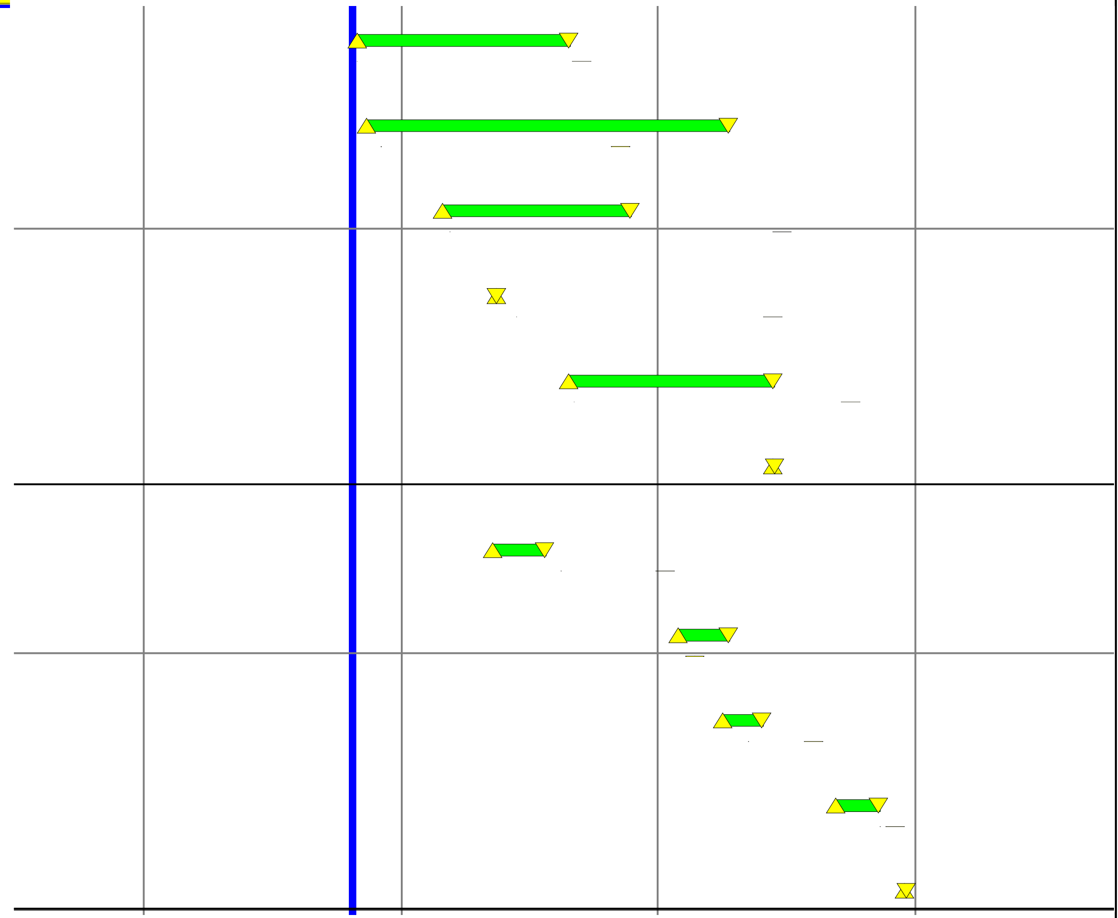
Sheet 1 of 2

FAME Project
Bus Development Summary
Schedule 10/31/01

Date	Revision	Checked	Approved

Bus Schedule (2 of 2)

tivity ID	Activity Description	[illegible] Type	Start	Finish



Sheet 2 of 2

S/C Bus I&T Issues

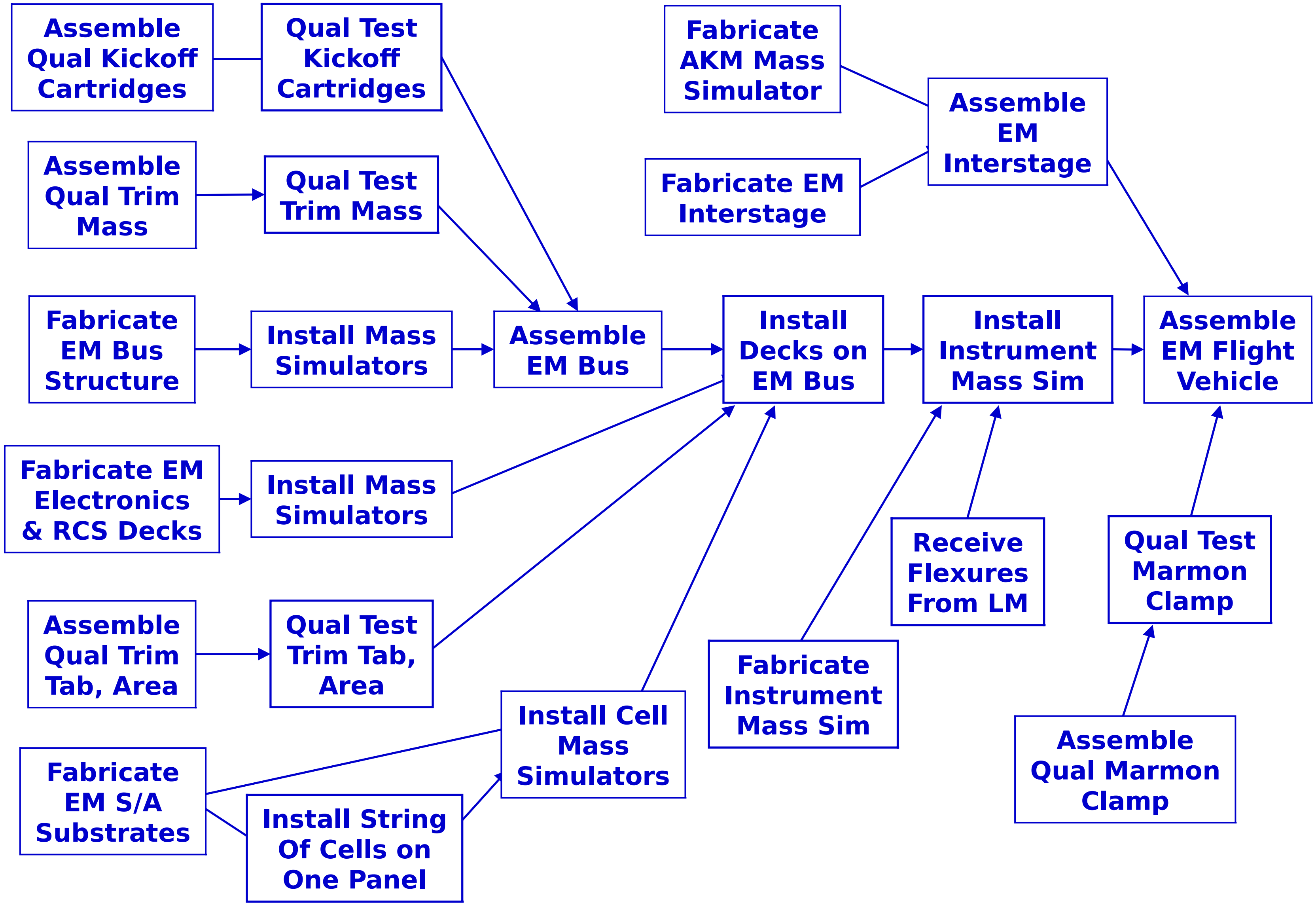
- **Bus Subsystem Mechanical Integration**
  - **As Design Matures, Need to Ensure That a Maximum Amount of Assembly Sequence Flexibility is Maintained**
- **Alignment Knowledge Requirement Verification**
  - **Use Engineering Model Alignments as Pathfinder & Develop Alignment Verification Plan for Flight Observatory**
- **Spin Balancing Observatory With Bag on Instrument**
  - **Potential for Errors Caused by Weight and Aerodynamics**
  - **Use EM Pathfinder Spin Balance to Assess Sensitivity**

Back-Up

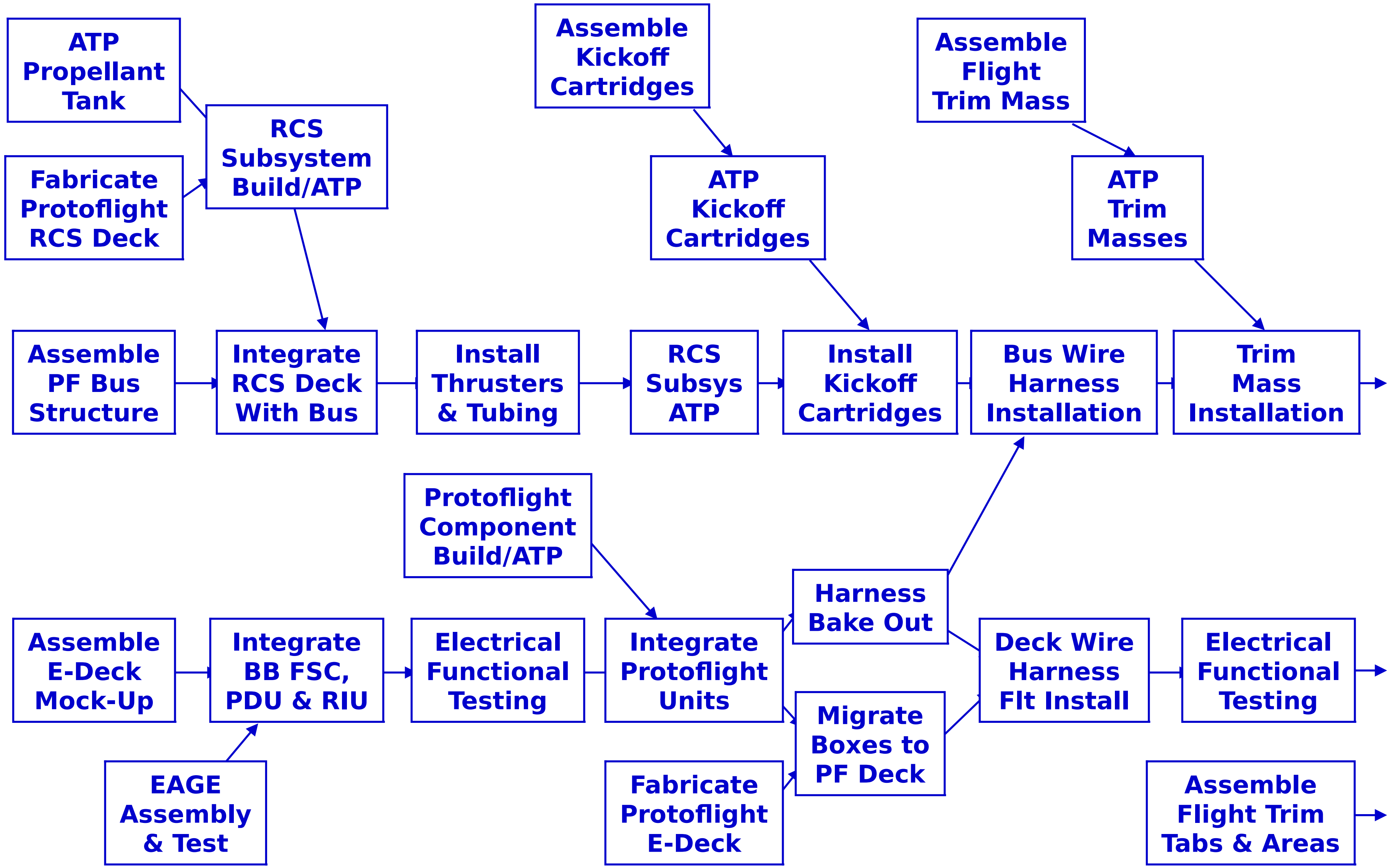
I&T, MAGE Peer Review Summary

- **Reviewers:**
  - John Ruffa GSFC Systems Engineer
  - Joe Hauser NRL Systems Engineer
  - George Flach NRL Systems Engineer
  - Russ Barnes BEI Systems Engineer
  - Kiera Gallelli NRL NEMO Program I&T Lead
  - Aaron Chilbert NRL ICM Mechanical Systems Lead
  - David Spencer NRL WindSat Program Manager
  - Mark Johnson NRL FAME Program Manager
  - Chris Garner NRL FAME Electrical Lead
  - Ron Mader NRL FAME Mechanical Lead
- **Issues Addressed:**
  - Ensure Availability of GSFC Loaned MAGE Hardware
  - CG Location When Lifting Observatory Without Interstage
  - Need Fixture for Lateral Moment of Inertia & Axial CG Measurements
  - Provide Higher Level Overview of Bus/Observatory Development
  - Detailed Test Matrix at PDR - Good

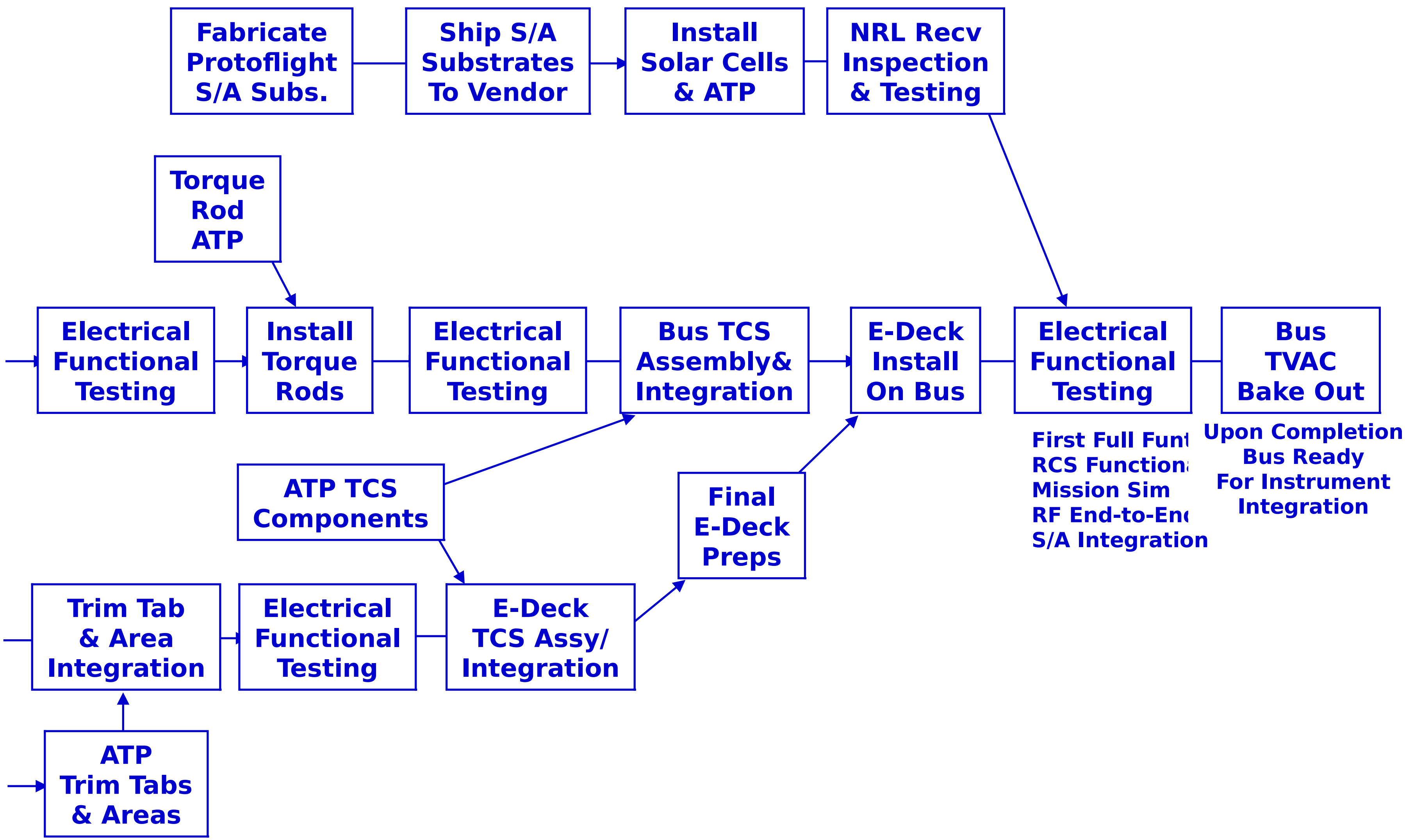
Engineering Model Assembly Flow



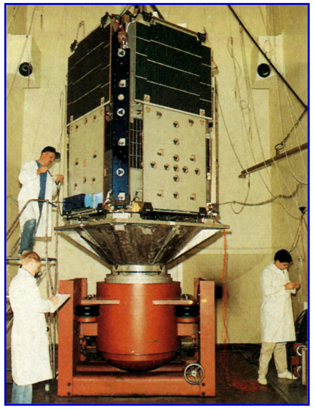
Flight Bus Assy & Integ Flow (1 of 2)

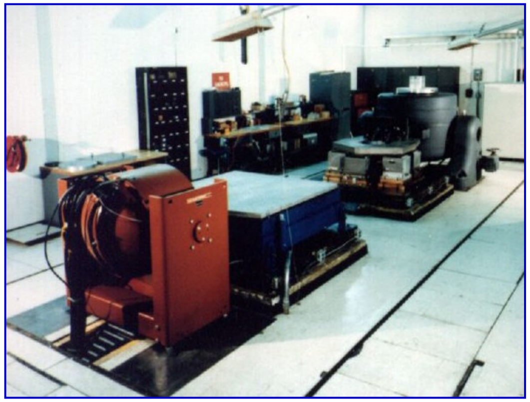


Flight Bus Assy & Integ Flow (2 of 2)



NRL Integration & Test Facilities





Anechoic Chambers **Acoustic Chamber** **Vibration Laboratory**

Spin Balance & MOI Machines **TVAC Chambers** **Clean Rooms**

- **NRL Building A59 Contains All of the Facilities Necessary to Integrate and Test FAME Program Space Segment Hardware**

Facility Capabilities

Test	Parameter of Merit	Program Requirement	Capability
Clean Rooms	Class Rating	Class 1000	Class 100 and Class 1000
Alignment Inspections	Angular Resolution	±10 Arc-Sec	±4 Arc-Sec
Magnetic Balance	Magnetic Dipole Balance Capability	200 mA-m^2 Per Axis	<150 mA-m^2 Per Axis
EMI/EMC	Chamber Size & Test Equipment Capability	9' x 9' x 8' Per Test Plan	31' x 31' x 25' IAW Test Plan
Spin Balance	Unbalance Resolution & Load Capacity	>4 Oz-in ~2000 lb (w Fixt)	4 Oz-in at 60 RPM 18,000 lb Capacity
Moments of Inertia	Measurement Accuracy & Load Capacity	±2 % Accuracy ~2000 lb (w Fixt)	±0.5% Accuracy 3000 lb Capacity
Acoustic	Chamber Size & Overall SPL Capability	9' x 9' x 8' 142.7 dB	16' x 21' x 26' >150 dB
Vibration	Equipment Capability	~10,000 Force-Lb	18,000 and 35,000 Force-Lb
Thermal Vacuum	Size & Vacuum Level	9' x 9' x 8' $1 x 10^{-5}$ Torr	16' Diam. x 30' Lg $< 1 x 10^{-6}$ Torr

Bldg A59 Clean Room Facilities

Facility	Best Cleanliness Level	Interior Size (L x W x H)	Entrance Size (W x H)
New Clean Room	Class 1000	44' x 23.7' x 20'	18' x 18'
Old Clean Room	Class 100*	35' x 29' x 10.5'	12' x 9.8'
Fixed Clean Tent	Class 100	17' x 17' x 18'	16' x 9'
Large Portable Clean Tent	Class 100	15' x 15' x 21'	15' x 20'
Small Portable Clean Tent	Class 1000	12' x 6' x 8'	12' x 7.5'

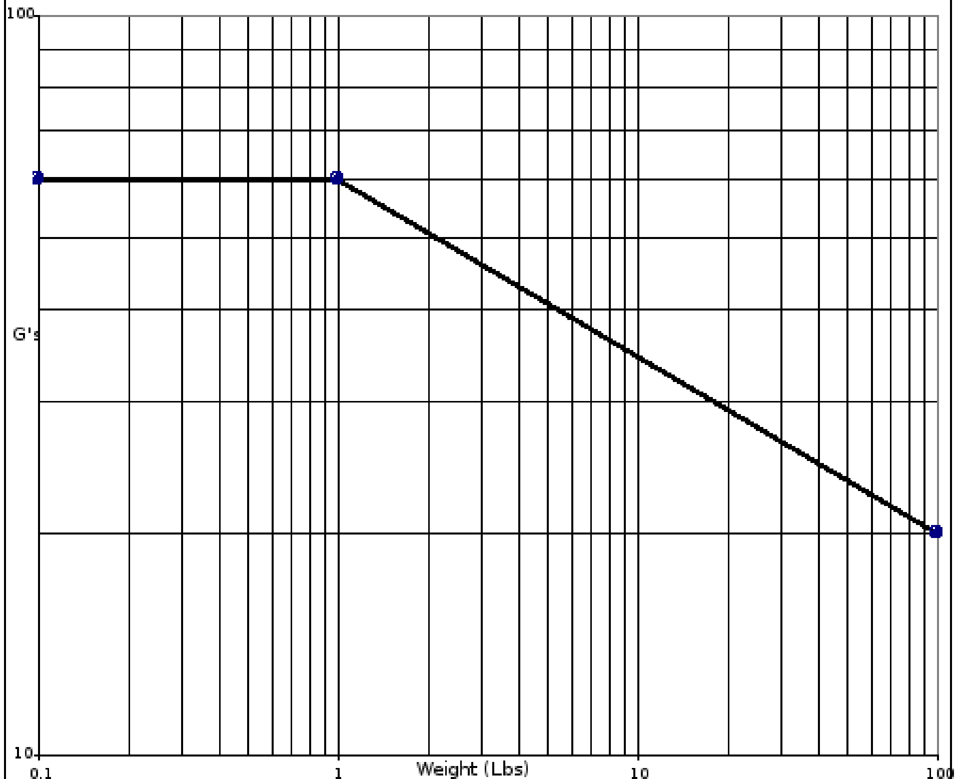
*Horizontal Flow Clean Room, Rating Applies Directly in Front of Filter Bank Only

FAME Observatory Dimensions:
- Height = 8.0 Feet (on Dolly)
- Diameter = 9.0 Feet

Alignment Knowledge Requirements

Component	Alignment Knowledge Requirement (WRT Bus Ref Axes)	Alignment Reference	Instrumentation	Anticipated Test Set Up
Instrument	±20 Arc-Sec (TBR)	Optical Cubes	Theodolite	Observatory on Rotary Table, Vertical Bar
Star Trackers	±10 Arc-Sec	Optical Cubes	Theodolite	Observatory on Rotary Table, Vertical Bar
IMUs	0.01 Degree	Mounting Surface	Reflective Target & Theodolite	Observatory on Rotary Table, Vertical Bar
Spinning Sun Sensors	0.1 Degree	Entrance Slits	Precision Inclinometer	Observatory on Precision Leveled Tooling Plate
Coarse Sun Sensors	1.0 Degree	Entrance Slits	Precision Inclinometer	Observatory on Precision Leveled Tooling Plate
Torque Rods	1.0 Degree	Cylindrical Section	Precision Inclinometer	Observatory on Precision Leveled Tooling Plate
Magnetometer	0.5 Degree	Edge of Component	Precision Inclinometer	Observatory on Precision Leveled Tooling Plate
Solar Array Flatness	5 mm Over 2 Meter Span	Cell Side of Panel	Theodolite	Observatory on Rotary Table, Vertical Bar
Trim Tabs and Trim Areas (Angle)	0.05 Degree	Surface of Trim Tabs & Areas	Theodolite and/or Inclinometer	Observatory on Rotary Table, Vertical Bar
Trim Masses (Installation Angle)	0.05 Degree	Translation Axis	CMM & Theodolite	Inspection of Piece Parts and Assembly (on Tooling Plate)
Propellant Tank	Within 0.05" of Bus CL	Mounting Surface	CMM & Theodolite	Inspection of Piece Parts and Assembly (on Tooling Plate)
5.0 Lbf Thrusters	0.1 Degree	Nozzle Exit Plane	Reflective Target & Theodolite	Observatory on Rotary Table, Vertical Bar
0.2 Lbf Thrusters	0.1 Degree	Nozzle Exit Plane	Reflective Target & Theodolite	Observatory on Rotary Table, Vertical Bar
AKM	0.1 Degree	AKM Mounting Bolt Circle	CMM & Theodolite	Inspection of Piece Parts and Assembly (on Tooling Plate)

Mass-Acceleration Curve



Fame Flight Level Acceleration Environment for Cor
All Three Axes

Design Accelerations

Component Wt. (Lbs)	G's
0.1	60
1	60
100	20

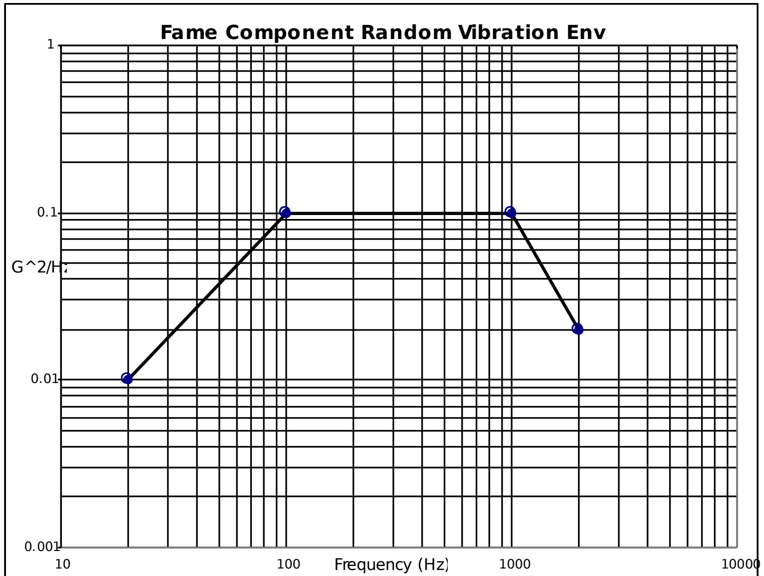
Design Acceleration Philosophy

* These accelerations are to be used for component testin by sine burst or centrifuge.

- Apprpriate factors of safety shall be applied to these accelerations

- For designated components, the acceleration level from this curve may also be used for vibration test tailoring

Bus Component Random Vibration



Bus RCS Thrusters Mounted to Cone
All 3 Axes

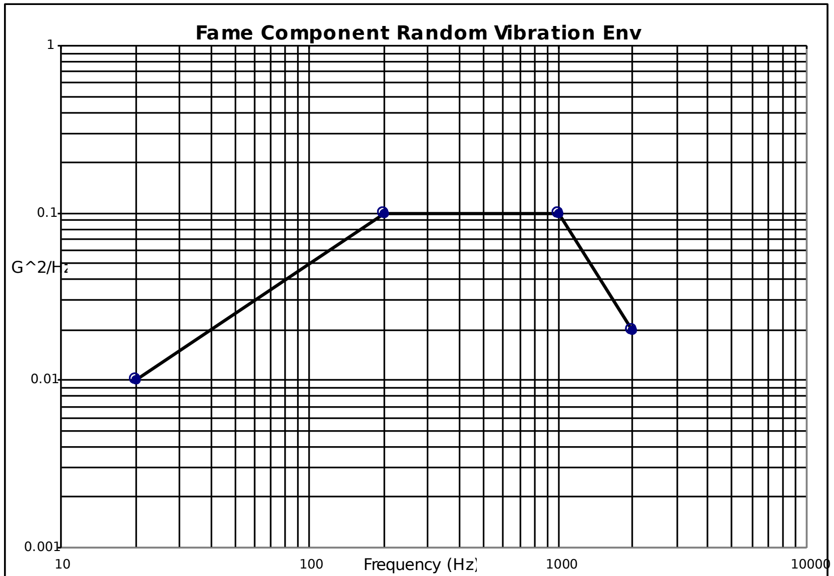
Flight Level Environment

Frequency (Hz)	G^2/Hz
20	0.01
100	0.1
1000	0.1
2000	0.02

11.8 Grms

Test Levels

	Margin Above Flight Level (dB)	Duration (Minutes)
Non-Flight Prototypes (Design & Qualification Level)	6	2
Flight Units (Protoflight Acceptance Test)	3	1



Bus Electronics Deck Mounted Comp
All 3 Axes

Flight Level Environment

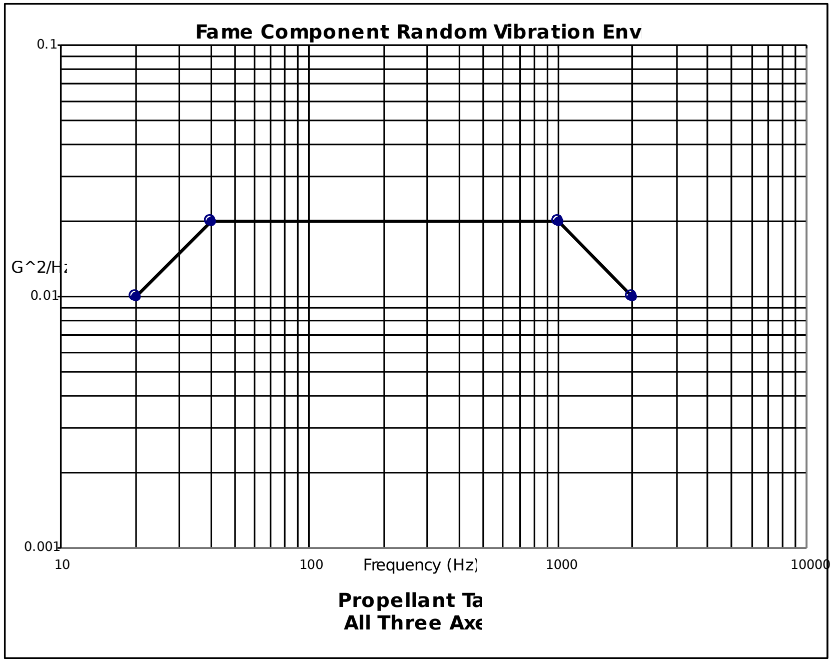
Frequency (Hz)	G^2/Hz
20	0.01
200	0.1
1000	0.1
2000	0.02

11.6 Grms

Test Levels

	Margin Above Flight Level (dB)	Duration (Minutes)
Non-Flight Prototypes (Design & Qualification Level)	6	2
Flight Units (Protoflight Acceptance Test)	3	1

RCS Tank & Deck Random Vibration

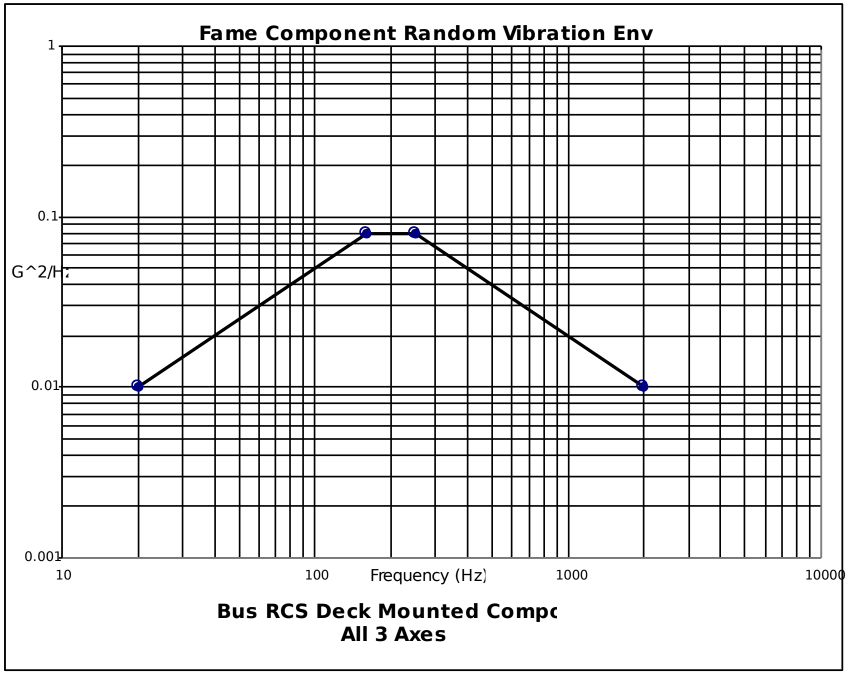


Flight Level Environment	
Frequency (Hz)	G^2/Hz
20	0.01
40	0.02
1000	0.02
2000	0.01

5.8 Grms OA

Test Levels

	Margin Above Flight Level (dB)	Duration (Minutes)
Non-Flight Prototypes (Design & Qualification Level)	6	2
Flight Units (Protoflight Acceptance Test)	3	1



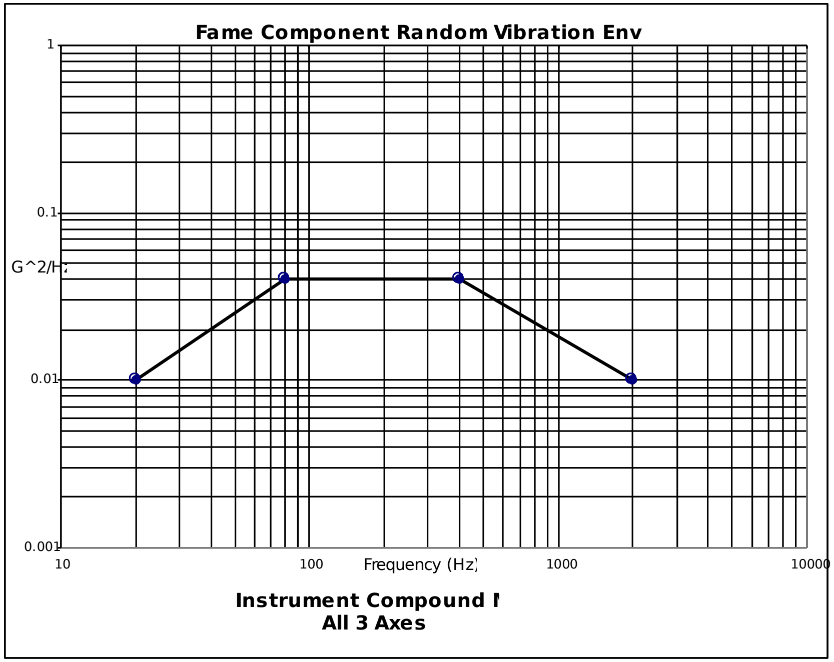
Flight Level Environment	
Frequency (Hz)	G^2/Hz
20	0.01
160	0.08
250	0.08
2000	0.01

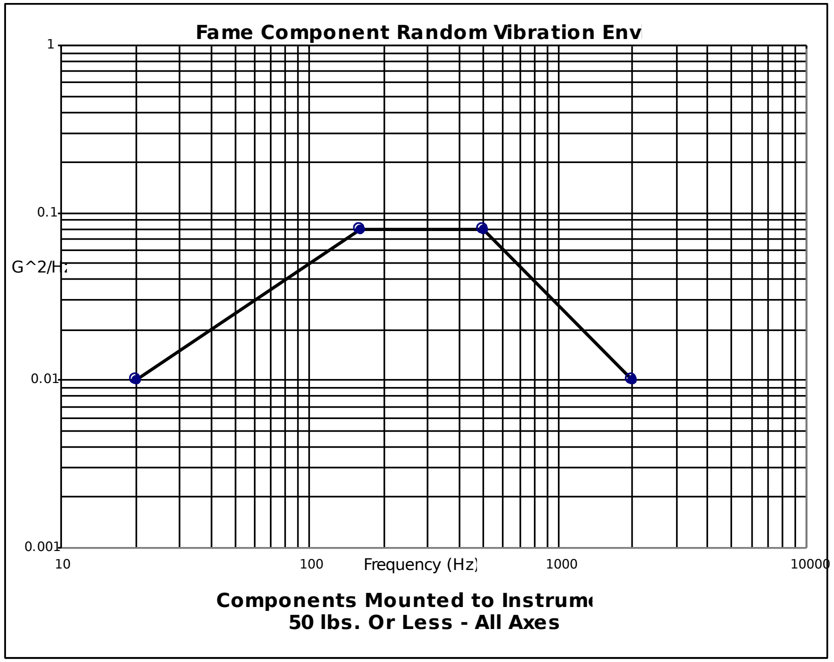
7.4 Grms

Test Levels

	Margin Above Flight Level (dB)	Duration (Minutes)
Non-Flight Prototypes (Design & Qualification Level)	6	2
Flight Units (Protoflight Acceptance Test)	3	1

Compound Mirror & Inst. Deck RV





Flight Level Environment

Frequency (Hz)	G^2/Hz
20	0.01
80	0.04
400	0.04
2000	0.01

6.6 Grms

Test Levels

	Margin Above Flight Level (dB)	Duration (Minutes)
Non-Flight Prototypes (Design & Qualification Level)	6	2
Flight Units (Protoflight Acceptance Test)	3	1

Flight Level Environment

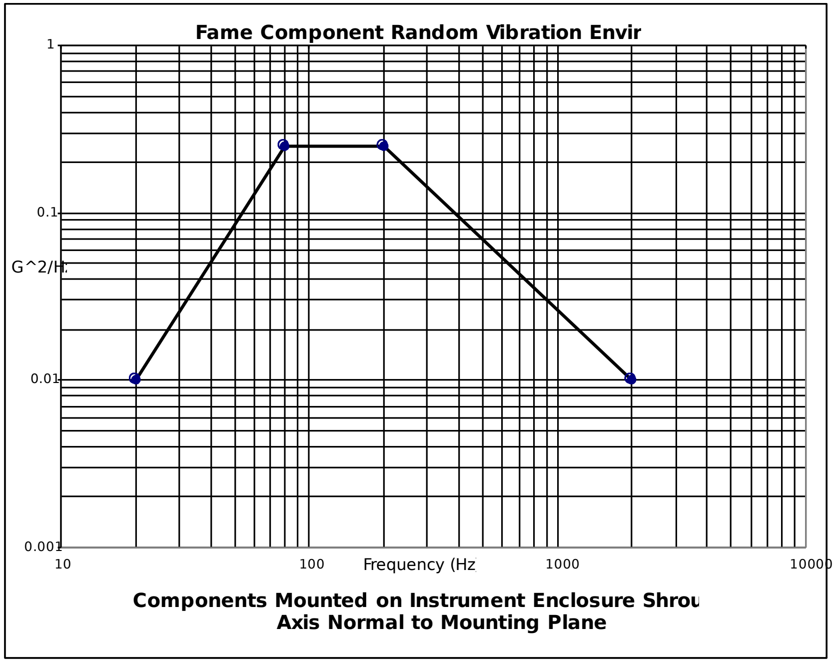
Frequency (Hz)	G^2/Hz
20	0.01
160	0.08
500	0.08
2000	0.01

8.6 Grms

Test Levels

	Margin Above Flight Level (dB)	Duration (Minutes)
Non-Flight Prototypes (Design & Qualification Level)	6	2
Flight Units (Protoflight Acceptance Test)	3	1

Instrument Enclosure Mounted RV



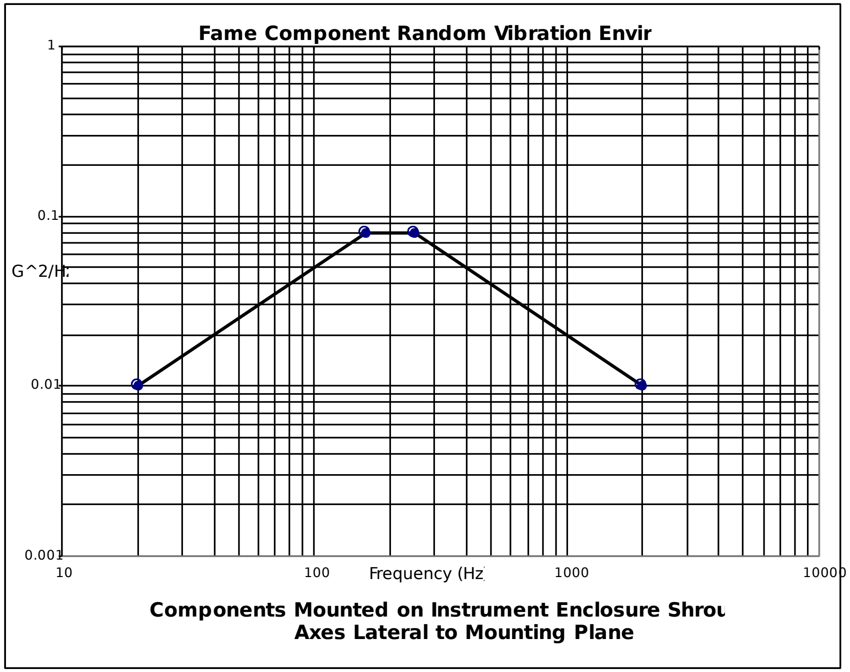
Flight Level Environment

Frequency (Hz)	G^2/Hz
20	0.01
80	0.25
200	0.25
2000	0.01

10.6 Grms

Test Levels

	Margin Above Flight Level (dB)	Duration (Minutes)
Non-Flight Prototypes (Design & Qualification Level)	6	2
Flight Units (Protoflight Acceptance Test)	3	1



Flight Level Environment

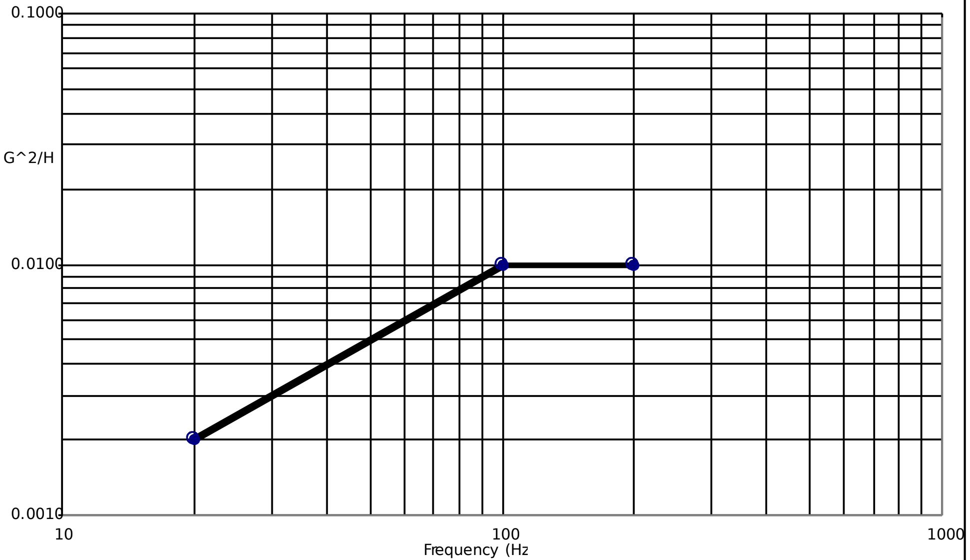
Frequency (Hz)	G^2/Hz
20	0.01
160	0.08
250	0.08
2000	0.01

7.4 Grms

Test Levels

	Margin Above Flight Level (dB)	Duration (Minutes)
Non-Flight Prototypes (Design & Qualification Level)	6	2
Flight Units (Protoflight Acceptance Test)	3	1

System Level Random Vibration



FAME System Flight Level Random Vibration En

Flight Level Environment

1.2 Grms Overall

Frequency (Hz)	G^2/Hz
20	0.0020
100	0.0100
200	0.0100

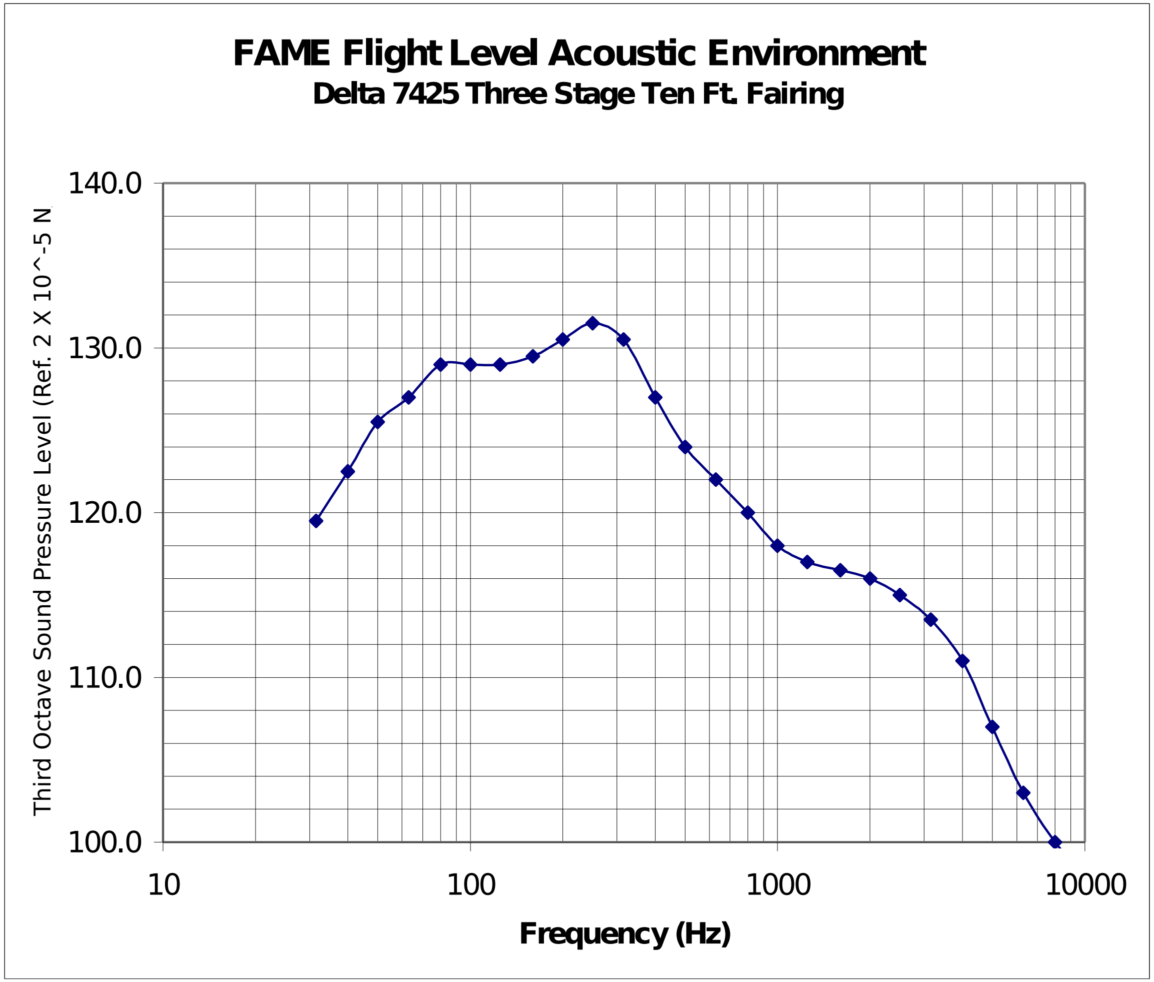
All 3 Axes

Test Level

	Margin Above Flight Level (dB)	Duration (Minutes)
Engineering Model (Qualification Level)	6	2
Flight Spacecraft (Protoflight Acceptance)	3	1

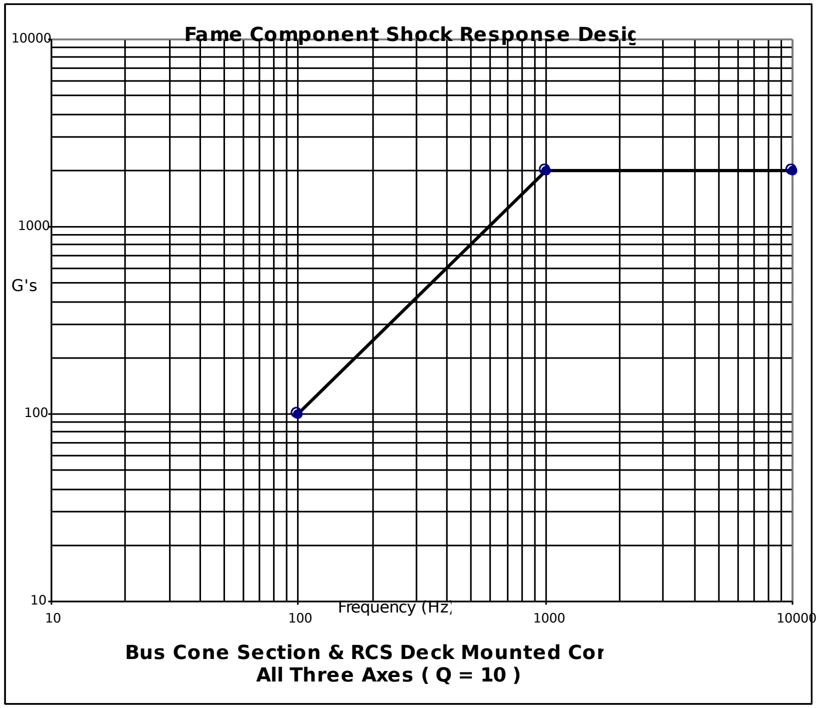
Note: The Spectrum will be tailored to keep primary structural responses below Dessign Limit Load X 1.05

System Acoustic Environment

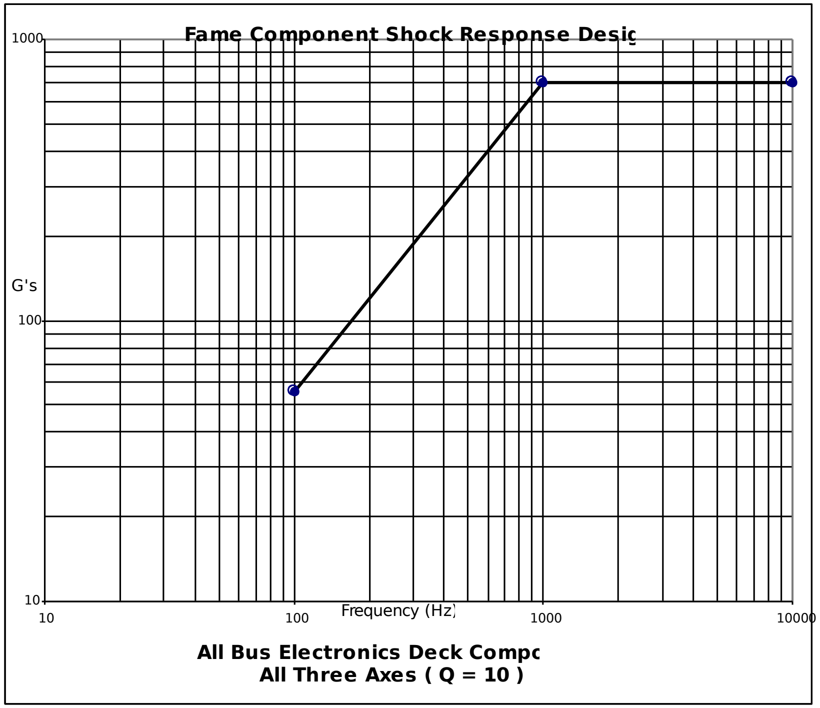


One Third Octave Frequency (Hz)	SPL (dB)
32	119.5
40	122.5
50	125.5
63	127.0
80	129.0
100	129.0
125	129.0
160	129.5
200	130.5
250	131.5
315	130.5
400	127.0
500	124.0
630	122.0
800	120.0
1000	118.0
1250	117.0
1600	116.5
2000	116.0
2500	115.0
3150	113.5
4000	111.0
5000	107.0
6300	103.0
8000	100.0
10000	98.0
OA	139.7
Duration	1 Minute

Component Shock Environment

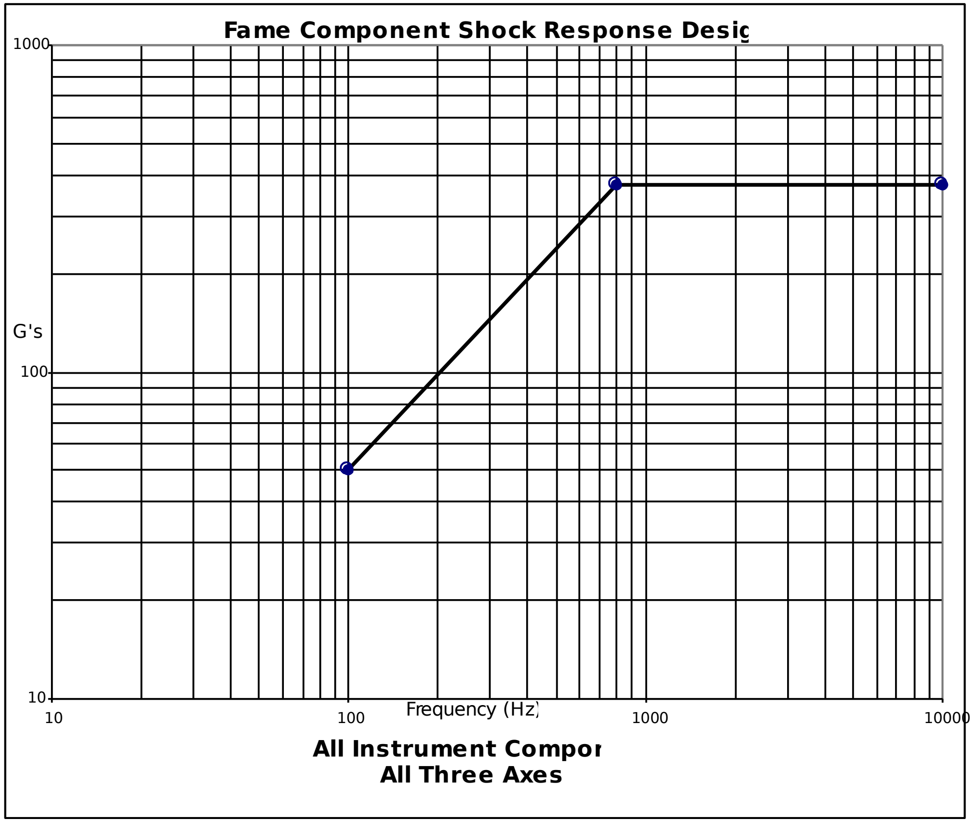


Design Environment Shock Response Spectrum Levels		Test Levels	
Frequency (Hz)	G's	Flight	1 Shock per Axis
100	100	Protoflight	2 Shocks per Axis
1000	2000		
10000	2000	Qualification	3 Shocks per Axis



Design Environment Shock Response Spectrum Levels		Test Levels	
Frequency (Hz)	G's	Flight	1 Shock per Axis
100	56	Protoflight	2 Shocks per Axis
1000	700		
10000	700	Qualification	3 Shocks per Axis

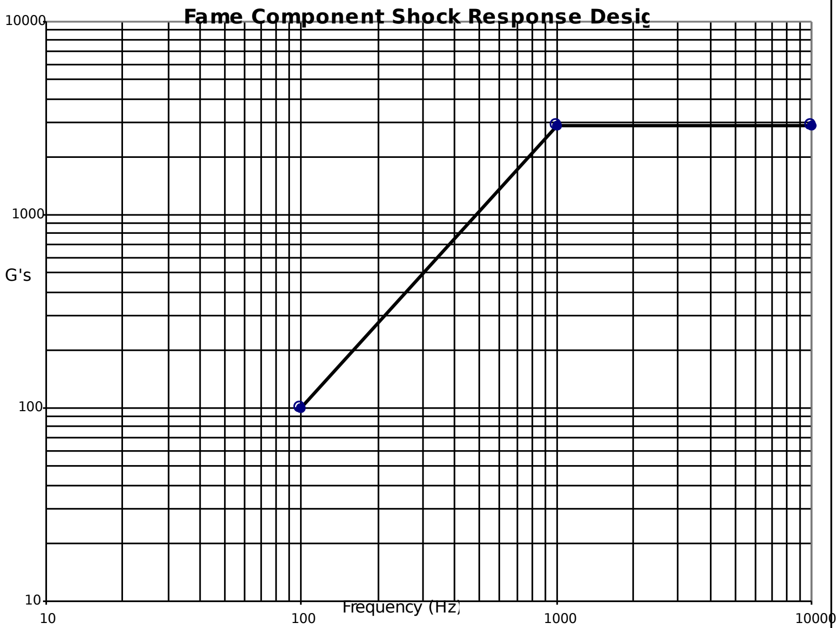
Instrument Shock Environment



Design Environment Shock Response Spectrum Levels		Test Levels	
Frequency (Hz)	G's	Flight	1 Shock per Axis
100	50	Protoflight	2 Shocks per Axis
800	375		
10000	375	Qualification	3 Shocks per Axis

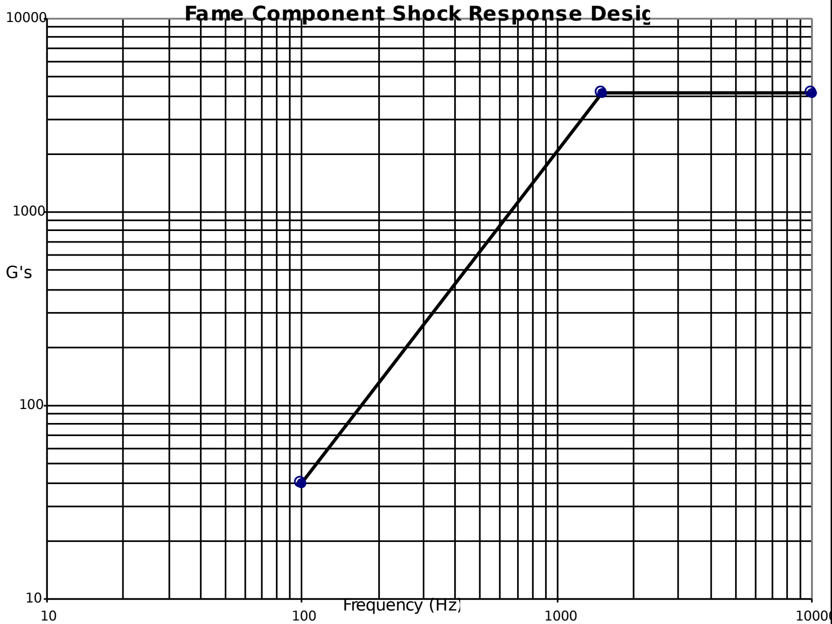
Q = 10

Interstage & Interface Shock Envir.



Interstage Mounted Comp
All Three Axes (Q = 10

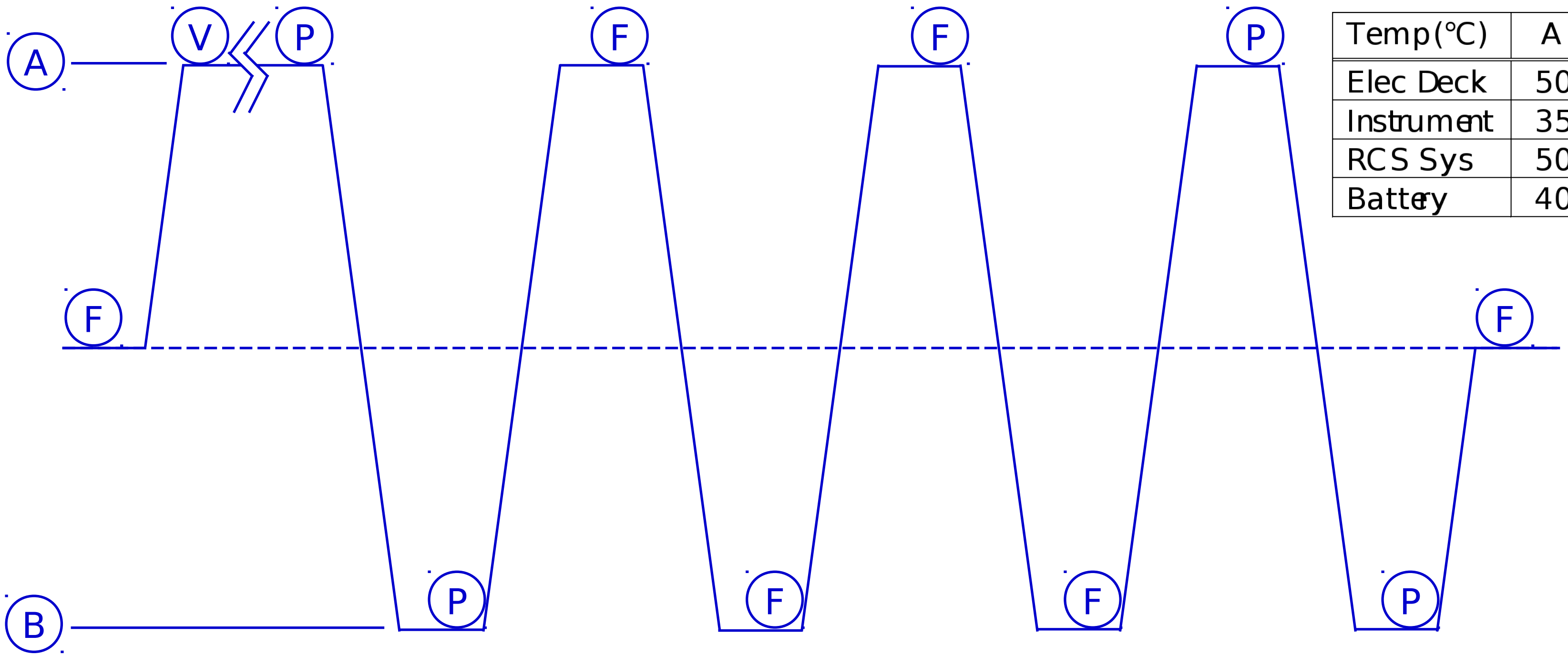
Design Environment Shock Response Spectrum Levels		Test Levels	
Frequency (Hz)	G's	Flight	1 Shock per Axis
100	100	Protoflight	2 Shocks per Axis
1000	2870		
10000	2870	Qualification	3 Shocks per Axis



Maximum Flight Level Payload / Booster Interface Sho
All Three Axes (Q = 10)

Maximum Environment Shock Response Spectrum Levels		Test Levels
Frequency (Hz)	G's	N / A
100	40	
1500	4100	
10000	4100	

TVAC Test Profile



Temp(°C)	A	B
Elec Deck	50	-10
Instrument	35	-10
RCS Sys	50	5
Battery	40	0

Notes:
- Temperature Tolerances: ± 2°C
- Temperature Ramps: < 1°C / min
- 2 Hour Soak at Extremes Prior to Testing
- Will Perform Hot and Cold Start Up Cases
- Will Demonstrate Operation During Ramps
- Vacuum Bake Out Duration Driven by Outgassing Rate as Determined by TQCM

V Vacuum Bake Out

F System Functional Test

P System Performance Test